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Resolution Boosting Filter for Spectrographs
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In recent experiments the spectral resolution of the Lick Observatory echelle grating spectrograph has been doubled by insertion of a small optical element at the entrance slit and by special processing of the data, while maintaining the original slit width and keeping other aspects of the spectrograph the same. Essentially, we have "eyeglasses" that can be reversibly inserted into the beam path of any spectrograph that boost its performance by factors of several. In addition to a resolution boost of 2-10x, the potential benefits include a dramatically improved resistance against systematic instrumental noise due to changes in shape of the light beam at the slit, aberrations of lenses in the spectrograph camera, and thermal or mechanical drifts of the CCD. Much more compact spectrographs per given resolution are now possible. A small Michelson interferometer having fixed delay is inserted into the light path. This filter embeds sinusoidal wavelength fiducials with the input spectrum, manifesting broad moire patterns that survive the slit blurring and are less sensitive to instrumental drifts. Special data processing recovers high spatial-frequency information that created the moire pattern, as well as the spectrum without the pattern. The technique is related to Fourier Transform spectroscopy, but has 100x times better photon signal to noise ratio, allowing use in astronomy and with other weak sources. Experiments to demonstrate 10x resolution boosting are underway.

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